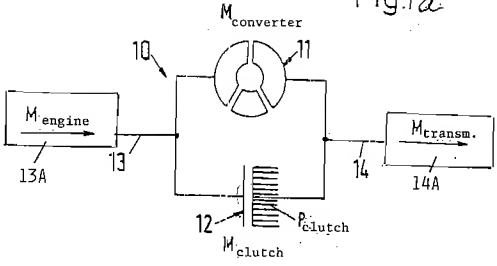
Fig.1a


M converter
10
11
M engine
13A
13
14
M transm.
14A
12
P clutch
M clutch

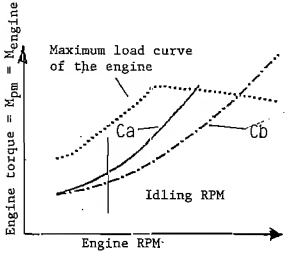

Engine torque = Mpm = Mengine
Maximum load curve of the engine
Ca
Cb
Idling RPM
Engine RPM

Fig. 1b

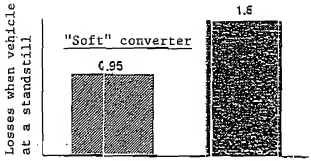


Fig. 1c

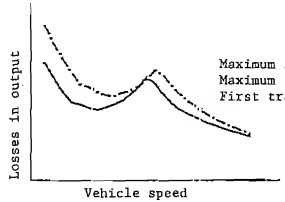


Fig. 1d

"Soft" converter
Standard converter

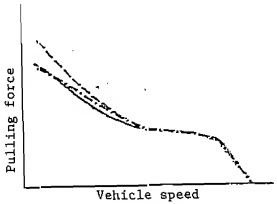
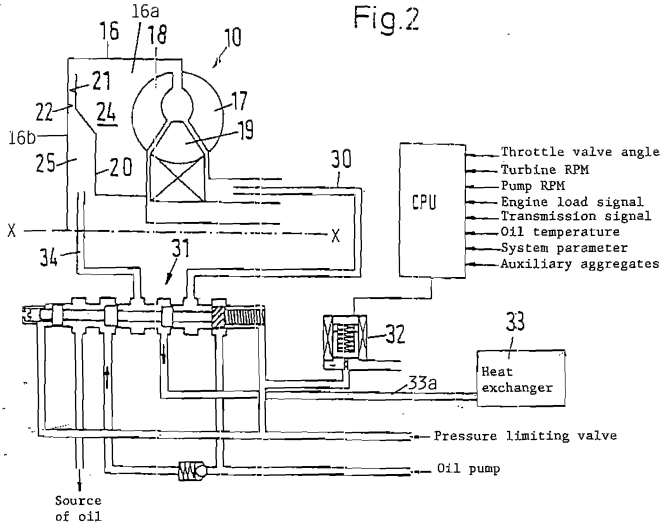


Fig. 1e

Standard converter
"Soft" converter
"Soft" converter with higher conversion

Fig.2


16a
16
18
10
21
22
24
17
19
16b
25
20
30
CPU
Throttle valve angle
Turbine RPM
Pump RPM
Engine load signal
Transmission signal
Oil temperature
System parameter
Auxiliary aggregates
X
X
34
31
32
33
33a
Heat exchanger
Pressure limiting valve
Oil pump
Source of oil

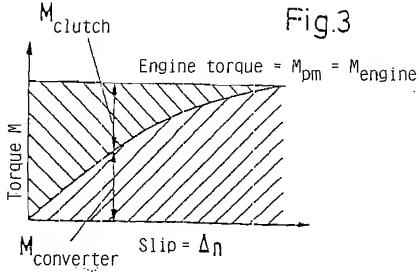


Fig.3

Fig.4

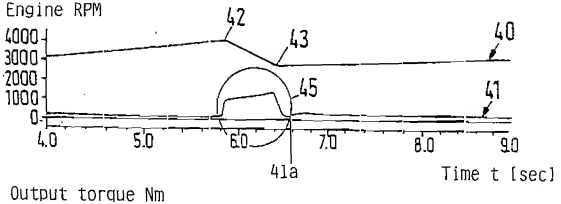


Fig.5

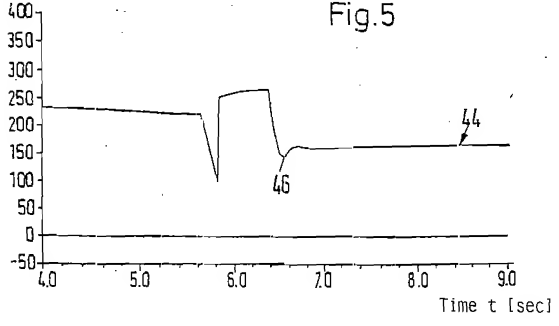


Fig.6

PRIOR ART

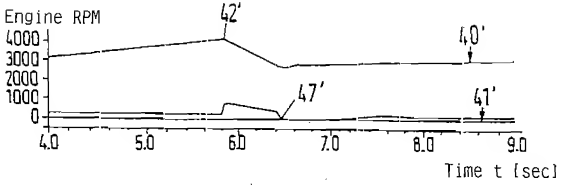


Fig.7

PRIOR ART

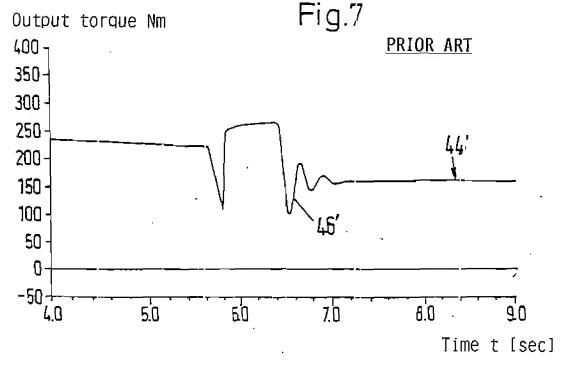


Fig.8

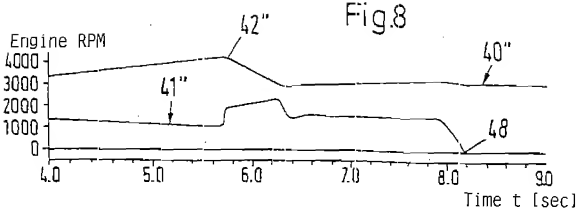


Fig.9

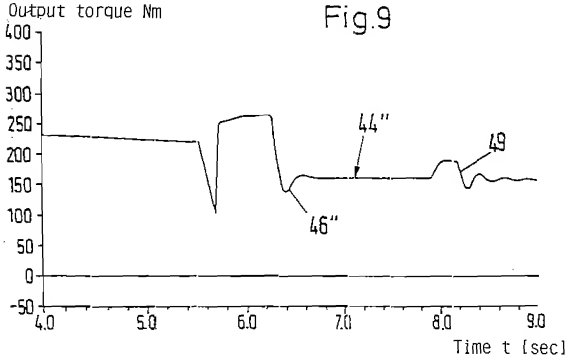


Fig.10

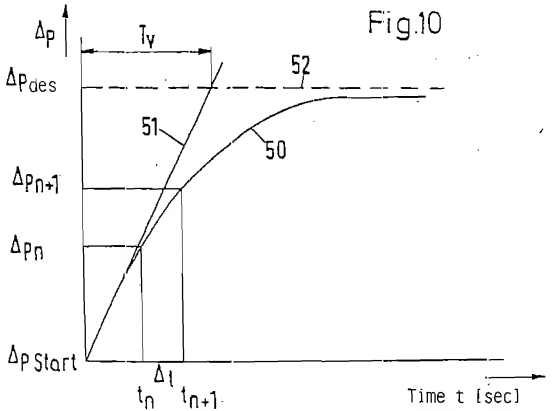


Fig.11a

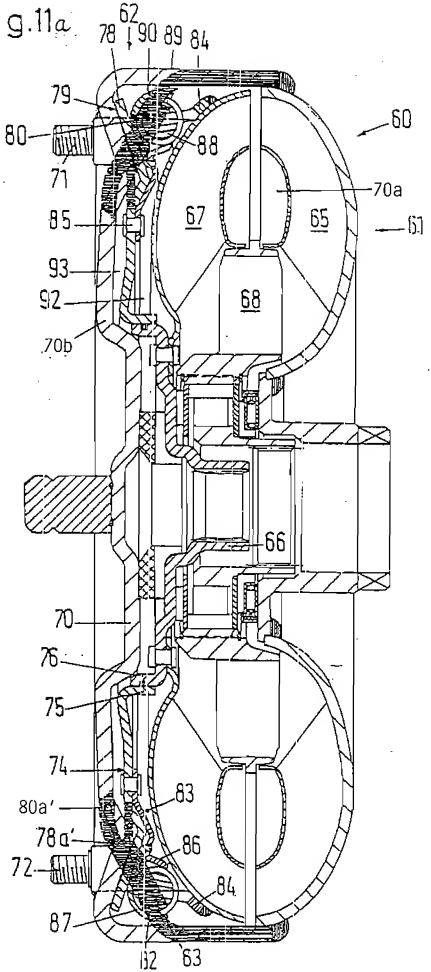

62
78
90
89
84
79
80
88
60
71
70a
67
65
61
85
93
68
92
70b
66
70
76
75
74
83
80a'
78a'
86
72
84
87
82
63

Fig. 11b

PRIOR ART

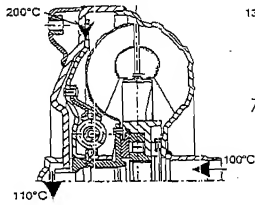


Fig. 11c

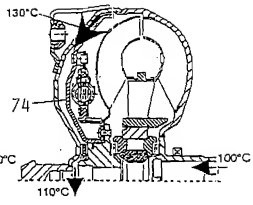


Fig. 11d

PRIOR ART

Maximum pressure per unit area: 100%

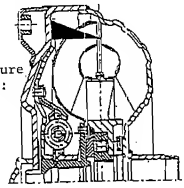
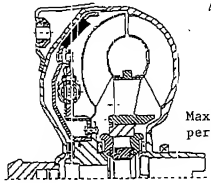


Fig. 11e



Maximum pressure per unit area: 25%

Fig.12

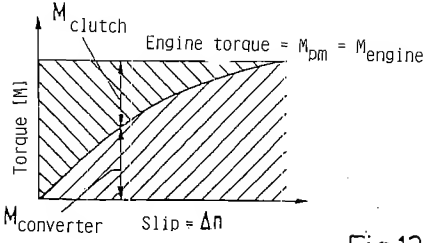
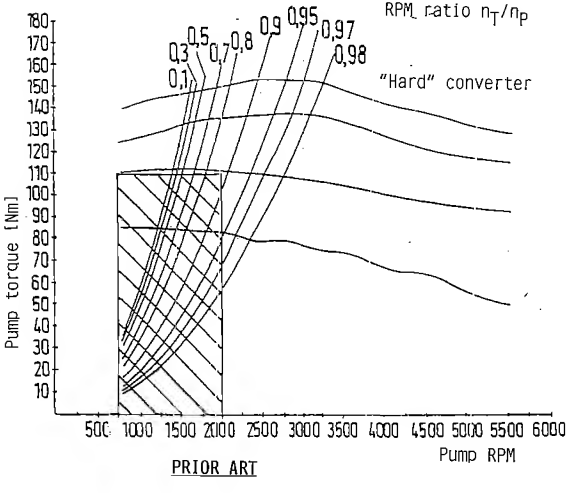


Fig.13



PRIOR ART

Fig.14

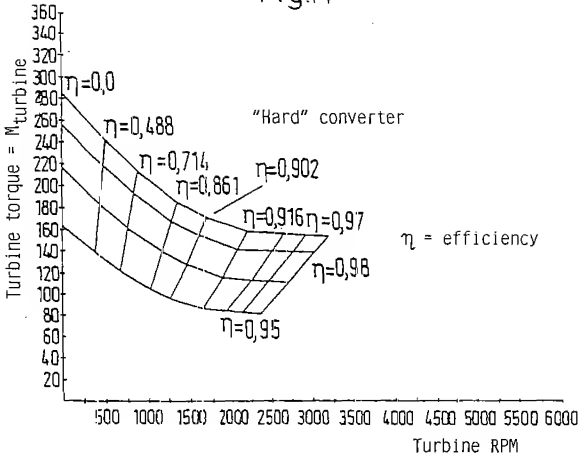

Turbine torque = $M_{turbine}$
360
340
320
300
280
260
240
220
200
180
160
140
120
100
80
60
40
20
η=0,0
η=0,488
η=0,714
η=0,861
η=0,902
η=0,916
η=0,97
η=0,98
η=0,95
"Hard" converter
η = efficiency
500 1000 1500 2000 2500 3000 3500 4000 4500 5000 5500 6000
Turbine RPM

Fig.15

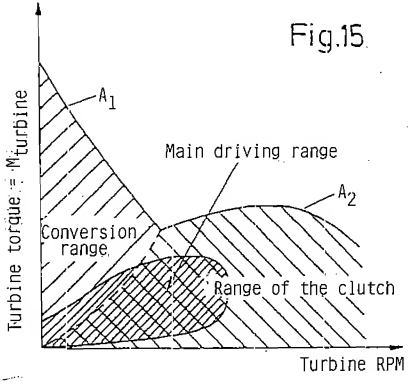

Turbine torque = $M_{turbine}$
A_1
Main driving range
A_2
Conversion range
Range of the clutch
Turbine RPM

Fig.16

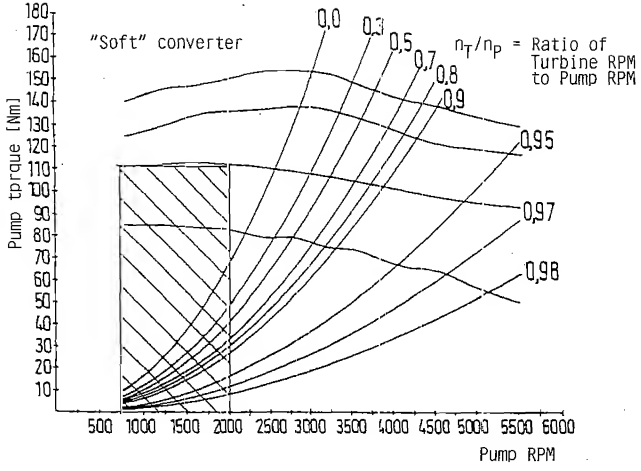

"Soft" converter
n_T/n_P = Ratio of Turbine RPM to Pump RPM
0,0
0,3
0,5
0,7
0,8
0,9
0,95
0,97
0,98
Pump torque [Nm]
Pump RPM

Fig.17

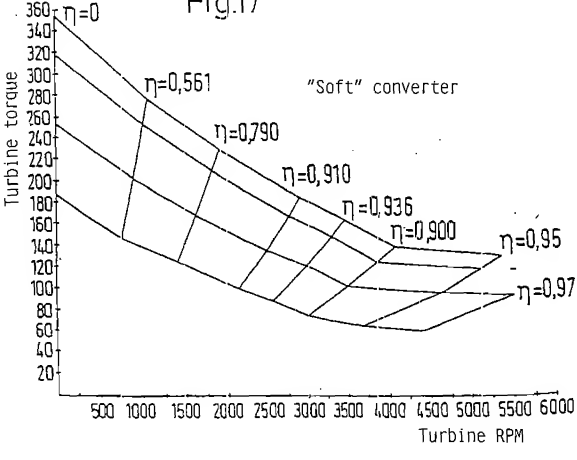

η=0
η=0,561
"Soft" converter
η=0,790
η=0,910
η=0,936
η=0,900
η=0,95
η=0,97
Turbine torque
Turbine RPM

Fig.18

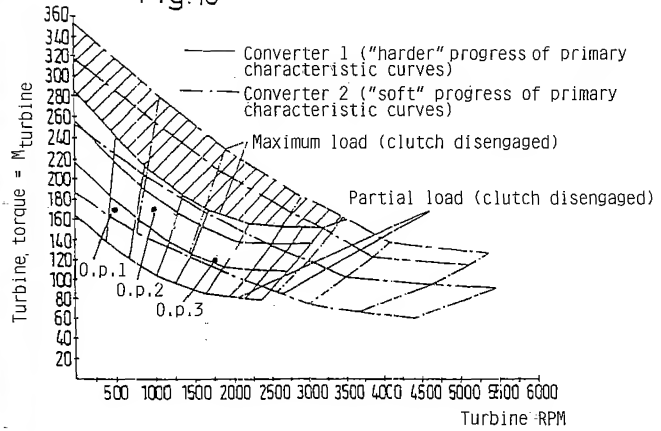

Converter 1 ("harder" progress of primary characteristic curves)
Converter 2 ("soft" progress of primary characteristic curves)
Maximum load (clutch disengaged)
Partial load (clutch disengaged)
O.p.1
O.p.2
O.p.3
Turbine torque = Mturbine
360
340
320
300
280
260
240
220
200
180
160
140
120
100
80
60
40
20
500 1000 1500 2000 2500 3000 3500 4000 4500 5000 5500 6000
Turbine RPM

Fig.19

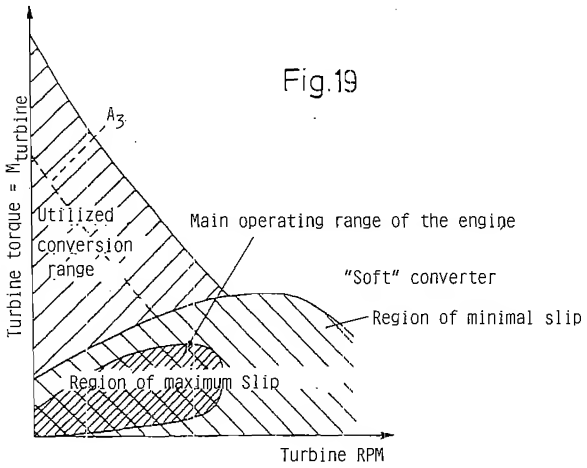
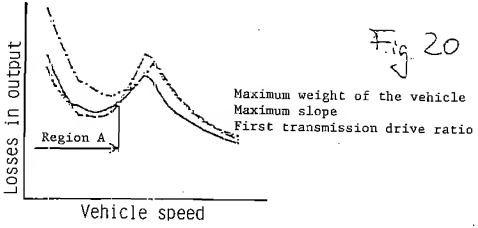

A3
Utilized conversion range
Main operating range of the engine
"Soft" converter
Region of minimal slip
Region of maximum Slip
Turbine torque = Mturbine
Turbine RPM

Fig. 20



— Conventional converter

—·— "Soft" converter

—·— "Soft" converter with higher conversion

Fig. 21

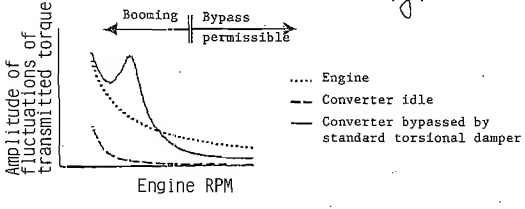


Fig. 22

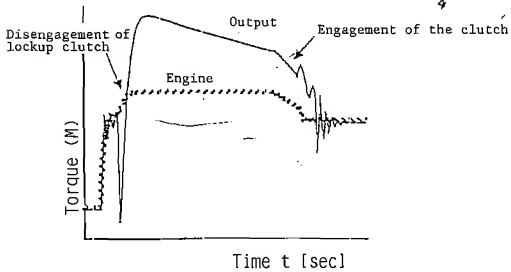


Fig. 23

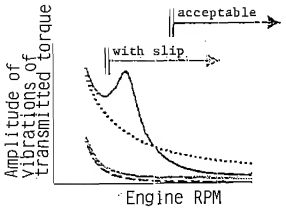
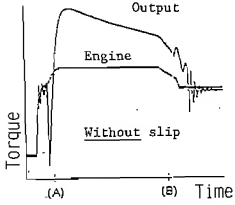
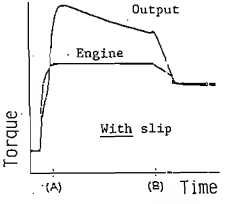


Fig. 24

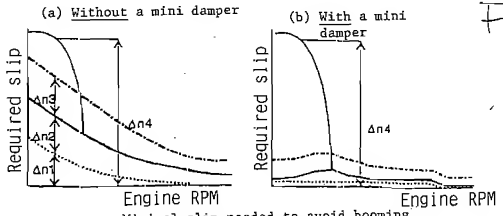


(A) Disengagement of the clutch



(B) Engagement of the clutch

Fig. 25



···· Δn1: Minimal slip needed to avoid booming

— Δn2: Slip needed to avoid drop of slip below a minimal value during unstable operation

-·- Δn3: Slip likely to develop during unstable operation

— Δn4: Slip necessary to avoid excessive choking of the engine

Fig. 26

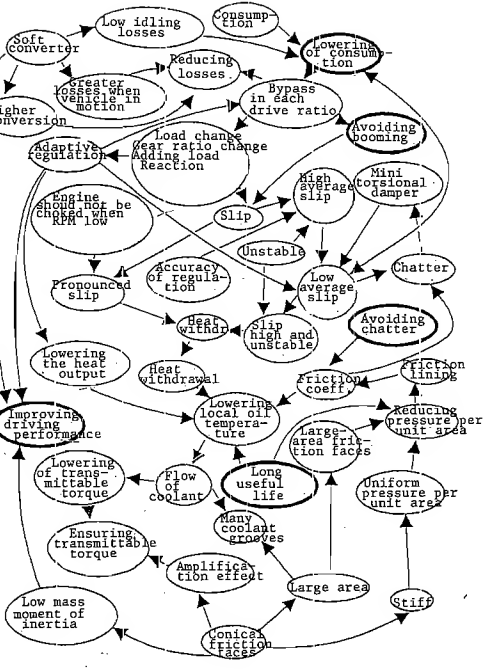
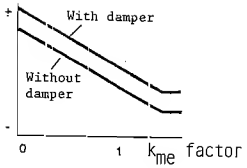
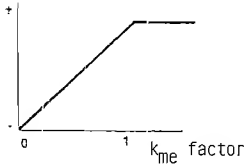

Consumption
Low idling losses
Soft converter
Lowering of consumption
Reducing losses
Greater losses when vehicle in motion
Bypass in each drive ratio
Higher conversion
Avoiding booming
Load change Gear ratio change Adding load Reaction
Adaptive regulation
Mini torsional damper
High average slip
Engine should not be choked when RPM low
Slip
Unstable
Chatter
Accuracy of regulation
Low average slip
Pronounced slip
Avoiding chatter
Heat withdr.
Slip high and unstable
Lowering the heat output
Friction lining
Heat withdrawal
Friction coeff.
Improving driving performance
Lowering local oil temperature
Reducing pressure per unit area
Large-area friction faces
Lowering of transmittable torque
Flow of coolant
Long useful life
Uniform pressure per unit area
Many coolant grooves
Ensuring transmittable torque
Amplification effect
Large area
Stiff
Low mass moment of inertia
Conical friction faces

Fig. 27

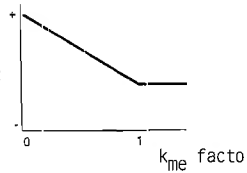
1. Acoustics



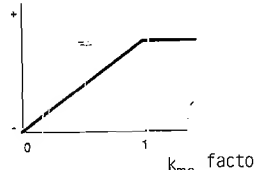
2. Thermal stressing



3. Pulling force



4. Consumption



5. Reaction to changes of load

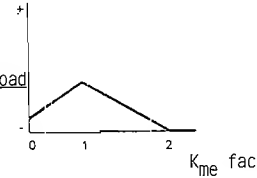


Fig. 28

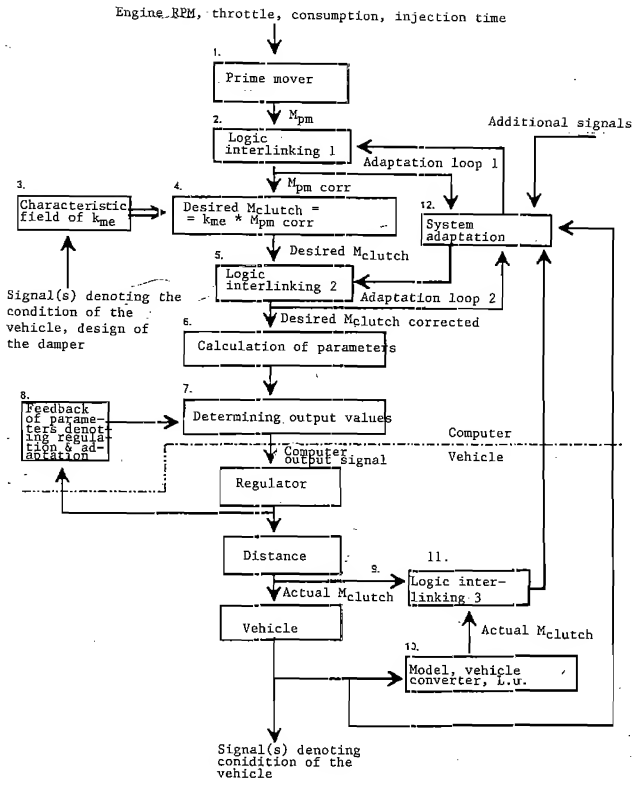
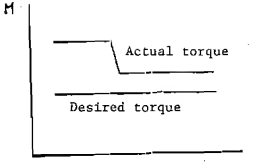

Engine RPM, throttle, consumption, injection time
1.
Prime mover
M_{pm}
2.
Logic interlinking 1
Adaptation loop 1
Additional signals
$M_{pm\ corr}$
3.
Characteristic field of k_{me}
4.
Desired M_{clutch} = k_{me} * $M_{pm\ corr}$
12.
System adaptation
Desired M_{clutch}
5.
Logic interlinking 2
Adaptation loop 2
Signal(s) denoting the condition of the vehicle, design of the damper
Desired M_{clutch} corrected
6.
Calculation of parameters
8.
Feedback of parameters denoting regulation & adaptation
7.
Determining output values
Computer
Vehicle
Computer output signal
Regulator
Distance
9.
11.
Logic interlinking 3
Actual M_{clutch}
Vehicle
Actual M_{clutch}
13.
Model, vehicle converter, L.u.
Signal(s) denoting conidition of the vehicle

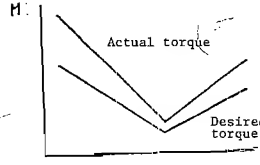
Fig. 29

Example 1:



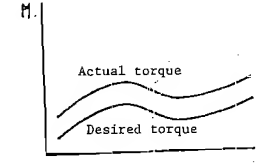
=> Additive share engine
(e.g., auxiliary aggregate(s))

Example 2:



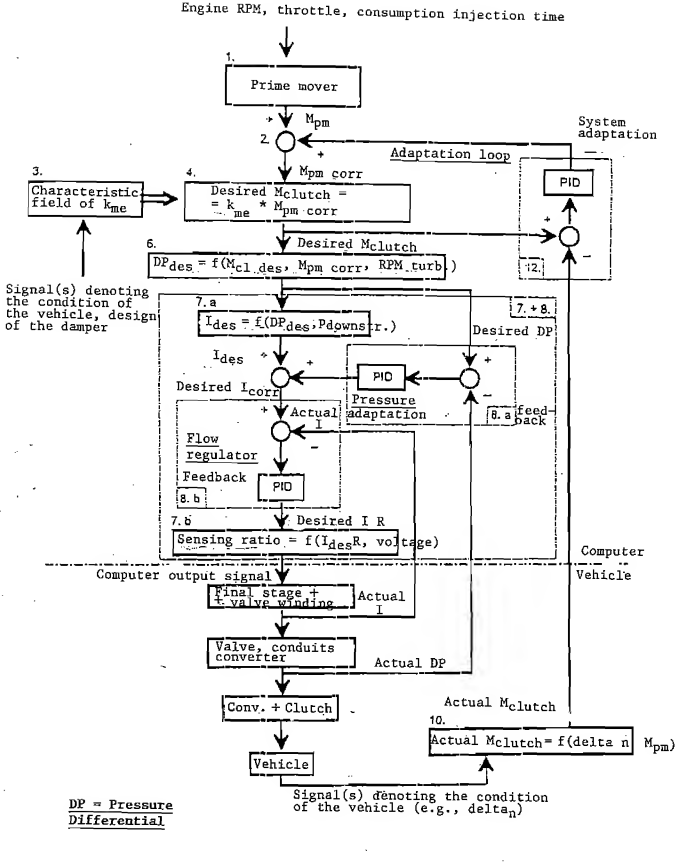
=>Multiplicative share clutch
(e.g., friction coefficient)

Example 3:



=> Additive share clutch
(e.g., deviation of controlling parameter)

Fig. 30



DP = Pressure Differential

Fig. 34

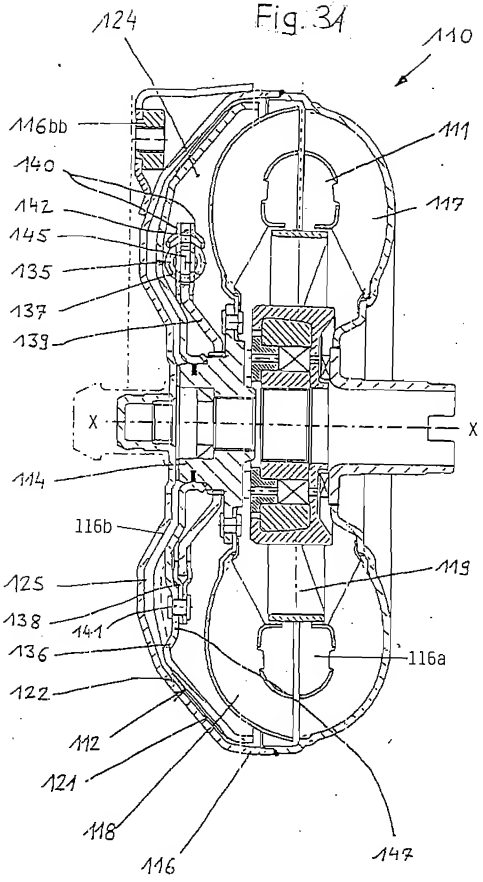

124
110
116bb
111
140
142
117
145
135
137
139
X
X
114
116b
119
125
138
141
136
116a
122
112
121
118
116
147

Fig 32

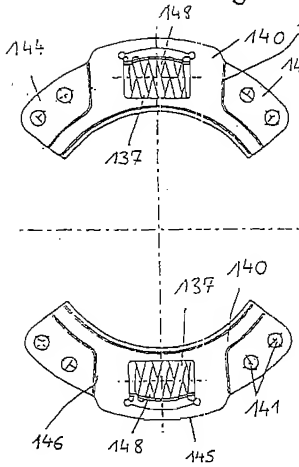

148
146
140
144
144
137
137
140
141
146
148
145

Fig. 33

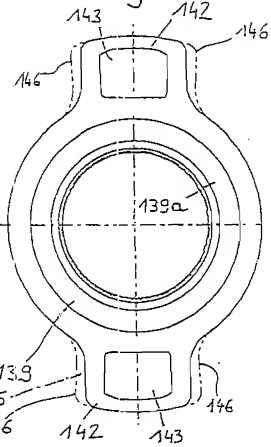

143
142
146
146
139a
139
145
146
146
142
143

Fig. 3

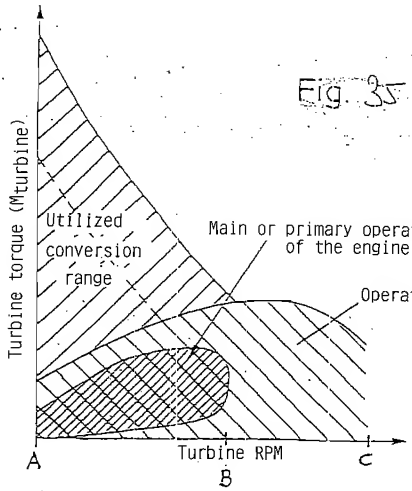
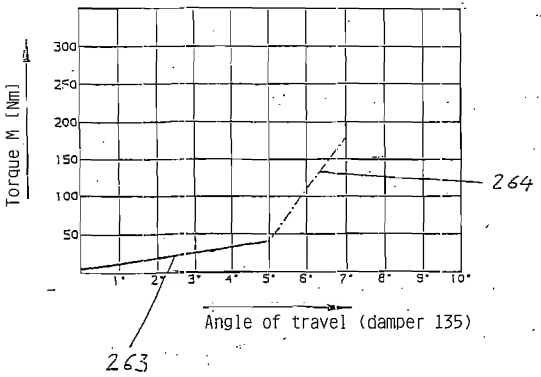

Turbine torque (Mturbine)
Utilized
conversion
range
Main or primary operating range
of the engine
Operation with slip
A
B
Turbine RPM
C

Fig. 4


Torque M [Nm]
300
250
200
150
100
50
1°
2°
3°
4°
5°
6°
7°
8°
9°
10°
264
263
Angle of travel (damper 135)

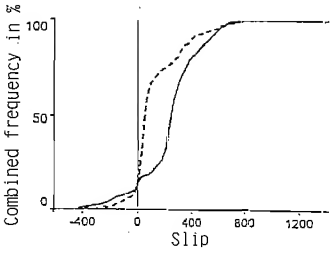


Fig. 36

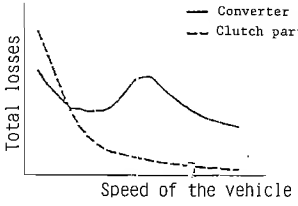


Fig. 37

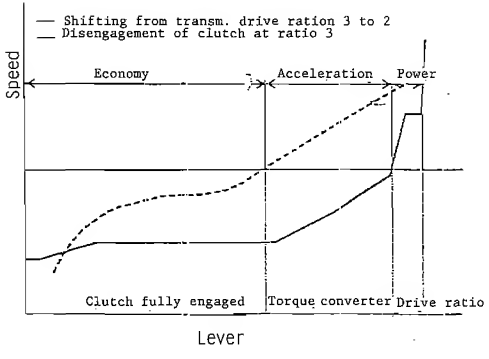


Fig. 38

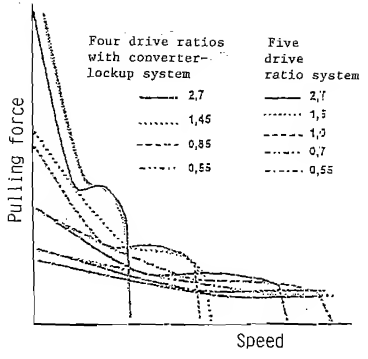

Four drive ratios with converter-lockup system
2,7
1,45
0,85
0,55
Five drive ratio system
2,1
1,5
1,0
0,7
0,55
Pulling force
Speed

Fig. 39